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THE PROTOCONCH OF *ACMÆA*.

BY WILL F. THOMPSON.

The protoconchs or embryonic shells of the Mollusca have been used by various writers as indicating the status of the various groups and their line of descent. The *Acmaeidæ* have many primitive characters, and it would be expected that the embryonic stages of the shell would show a like condition. It has been stated that these forms possess a coiled nautiloid protoconch by Grabau, '03; Pelseneer, '06; Fisher, '04; Verrill, '96, and others. In a recent article by Morse, '10, this is declared erroneous, and figures and descriptions are given of a stage of *Acmaea testudinalis* in which there is shown "simply a cæcal-like shell with slight dorsal flexure" and "a slight elongated area rounded anteriorly" at either side where the embryonic shell joins the permanent.

The specimens of *Acmaea* cited by Dr. W. K. Fisher were given to me by Dr. Harold Heath, with the request that I investigate them. I thank him for his kindness, as well as Dr. J. P. Smith.

The material was imbedded in very hard paraffin, either entire or in part decalcified, and sectioned. This method gave but poor results, and better were obtained by observing the specimens in reflected light under high powers of the microscope. By carefully working over the débris picked up with the young limpets, decolated shells were found without the embryo within them and hence in excellent condition for observation. All the material came from the tide pools of Monterey Bay, but the species could of course not be certainly identified.

The general appearance of the shell may be seen in fig. 1. A slight asymmetry is visible, the posterior apex of the protoconch being to the left of the adult axis, although symmetrical to that of the larva itself. In view of the presence in nearly related mollusks of naticoid and planorboid coils, this probably has but very little significance. The "lateral folds" of Morse, '10, are very evident and easily seen (fig. 2), leading, if seen from one side, to the appearance of a true spiral coil, but present on both sides. The right-hand one is in the greater number of cases slightly longer than the left, in harmony with the slight asymmetry. As may be seen in figs.

2 and 3, the margin of the embryonic shell and its connection with that of the permanent patelloid shell is in the plane of the lower edge of the lateral pouches or folds of Morse. The first of the growth lines of the patelloid shell run under the protoconch below

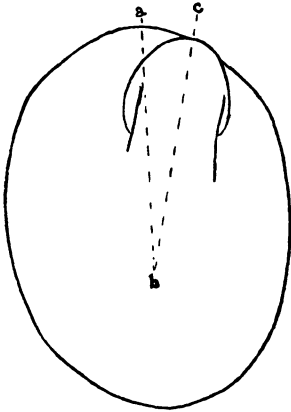


Fig. 1.—*Acmæa* sp. Protoconch on first of adult shell.

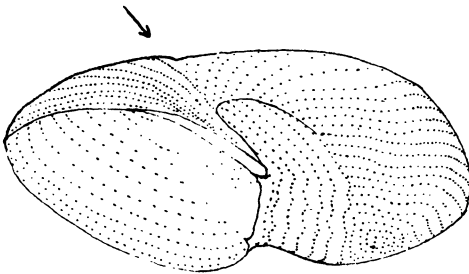


Fig. 3.—Protoconch and first of adult shell of *Acmæa* sp. showing growth lines, upper edge of adult shell indicated by the arrow. Camera lucida, looking at the bottom and one side.

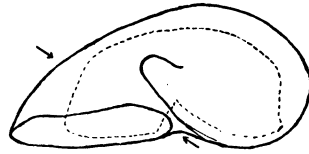


Fig. 2.—Protoconch of *Acmæa* sp. from side, showing first of adult shell. Line of base of protoconch indicated by arrows.

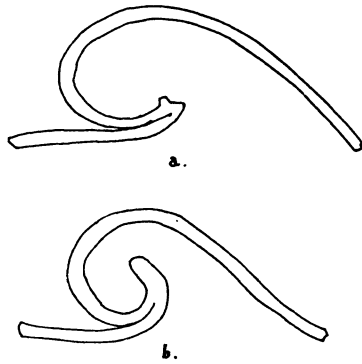


Fig. 4.—Protoconch of *Acmæa* sp. *a*, Sagittal section through centre of shell, on line of *bc* of fig. 1. *b*, Somewhat oblique section on line *ab* of fig. 1.

the middle of the lateral "pouches" (fig. 3), as may be seen in Morse's fig. 5, although his fig. 4 shows a different condition.

In sagittal section there is shown merely a cæcal-like shell with the suggestion of a coil in the form of the ridge or inner anterior margin of the protoconch (fig. 4*a*). This appearance is further strengthened by the section of a shell with the animal still within it (fig. 5). The shell in this has been slightly decalcified. By making a somewhat oblique section of one side (fig. 4*b*), a still

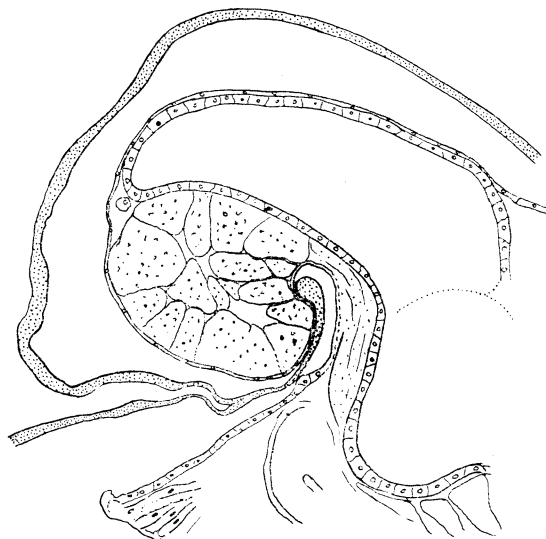


Fig. 5.—*Acmæa* sp. Section of protoconch with portion of young still within it. Shell stippled.

more striking appearance of a coil is obtained. This is true of both sides of the protoconch. The lateral edges, then, of this ridge shown in the median sections of the shell are simply turned back or "coiled" to a greater degree than the central part and the lateral marks are the external evidences of this condition, the "folds" being the union of the ridge with the outer wall of the shell. This is shown in figs. 2 and 6.

If this were a true coil the lines of growth would be expected to bear it out. By observation under the high powers in direct reflected light it is possible to discern these lines in the species under consideration. They are very regular, clear, and well marked. In fig. 3 a camera lucida drawing is shown. Their center seems to be on the lower surface of the protoconch. Those of the lateral pouches are shown to be parallel to their long axis and not conformant below the shell to those behind them. What the significance of this state of affairs may be I cannot hazard a guess, and it appears as though its explanation must await the complete working out of the embryology which Patten was unable to carry so far. The embryo in the youngest stages which I sectioned occupies these corners with portions of the liver. Judging from the lines of growth, one would be tempted to think that these pouches were formed later

than the middle portion of the protoconch and subsequent to a resorption of the posterior edge. If they were remnants of a true coil it would be expected that growth should take place in them first.

As mentioned above, the liver, at the earliest stage I had, occupied a part of the protoconch with its large granulated cells (fig. 5). In company with it was one loop of the large, thin-walled alimentary canal. This is well past the veliger stage and when the embryo is fairly complex. There were no gills present. At a period slightly later than the stage represented in fig. 1, the protoconch is broken off, leaving a cicatrix. The lower part of the primitive shell seems in some cases at least to remain on the patelloid shell to form the posterior part of the cicatrix. This has been fully described by previous authors.

In conclusion, it may be stated that the protoconch gives more evidences of being a simple cæcal-like shell than coiled, although the evidences are open to other interpretations. The slight coil of the body and shell and a tendency of the shells to form more rapidly anteriorly than posteriorly at first would indicate the presence

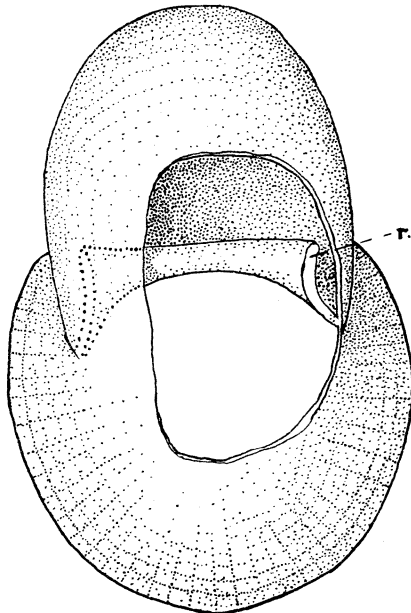


Fig. 6.—Protoconch and beginning of permanent shell of *Acmaea* sp. in optical section, from dorsal surface. *r*, Ridge at upper line of lateral pouch.

of a coil in the ancestral shell, which may have been altered by cæogenetic variation and the resorption of parts. The structure and disposal of the growth lines, the simple character of the lateral pouches and their small size in proportion to the size of the egg and larva, indicate that they are caused by something other than a coil. *Trochus*, *Natica*, *Nassa*, *Eolis*, or Ammonite and nautiloid protoconchs do not seem to differ much from the structure described above.

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